WIRELESS METROLOGY COMMUNICATION

Background

This disclosure relates to industrial metrology. More specifically, the disclosed embodiments relate to systems and methods for wirelessly communicating gauge measurements and/or operation information.

In some cases, manufactured parts, such as relatively large airplane skins, spars, and stringers, are measured (e.g., checked for tolerance off of CNC automation) with one or more gauges, which may be moved along the manufactured parts to take measurements at different locations. These gauges may be connected to a computer with relatively expensive data cables. Because the respective gauges are tethered to the computer by the associated data cables, the computer, gauges, and data cables are typically loaded onto a cart and moved along the part as the measurements are performed. However, the data cables may become significantly worn as a result, sometimes requiring costly replacement. Further, data transmitted from a gauge to the computer over the associated data cable generally corresponds to only a raw measurement taken on the part by the gauge. A human operator of the gauge generally must stay within close proximity to the computer to be able to accept or reject the transmitted data before it is included into an automated measurement recording system.

Summary

Disclosed herein are various examples of systems and methods providing wireless metrology communication.

According to an aspect of the disclosure, there is provided a method of communicating a gauge measurement comprising: receiving from a gauge a measurement signal representative of a measurement output by the gauge by a wireless metrology assembly when the wireless metrology assembly is operatively coupled to the gauge; producing from the received measurement signal, by the wireless metrology assembly, a communication signal representative of the measurement; and wirelessly transmitting, by the wireless metrology assembly, the communication signal according to a wireless network protocol.

According to another aspect of the disclosure, there is provided a method of communicating a gauge measurement comprising: receiving from a gauge a measurement signal representative of a measurement output by the gauge; producing a communication signal representative of the measurement; wirelessly transmitting the communication signal according to a wireless network protocol; wirelessly receiving the transmitted communication signal; determining the measurement from the received communication signal; storing the determined measurement on a first storage device; outputting by a computer to a display device a display signal representative of the measurement output by the gauge; receiving, on a wireless feedback device physically and operatively separate from and independently movable relative to the gauge and relative to the computer, a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement displayed on the display device; wirelessly transmitting by the wireless feedback device a feedback signal representative of the user input; receiving the transmitted feedback signal; and processing the determined measurement based at least in part on the received feedback signal.

According to another aspect of the disclosure, there is provided a wireless metrology assembly comprising an input/output controller and a first wireless network controller operatively coupled to the input/output controller, the input/output controller configured to receive from a gauge when the wireless metrology assembly is operatively coupled to the gauge, a measurement signal representative of a measurement output by the gauge, and to produce a communication signal representative of the measurement, and the first wireless network controller being configured to wirelessly transmit the communication signal according to a wireless network protocol.

According to a further aspect of the disclosure, there is provided a wireless metrology system comprising: a wireless metrology assembly having at least one input device configured to receive an indication relating to a measurement, the indication being manually entered on the at least one input device and corresponding to at least one of a plurality of inputs selectable by a user, the wireless metrology assembly being configured to receive from a gauge when the wireless metrology assembly is operatively coupled to the gauge a measurement signal representative of a measurement output by the gauge, to wirelessly transmit a communication signal representative of the

measurement signal, and to wirelessly transmit a feedback signal representative of the entered indication; a display device configured to display a display signal; and a base assembly configured to wirelessly receive the transmitted communication signal, to communicate to the display device the display signal including an indication of the measurement output by the gauge, and to wirelessly receive the feedback signal.

In one example, a method of communicating a gauge measurement may comprise receiving from a gauge a measurement signal representative of a measurement output by a gauge. The method may further comprise producing a communication signal including the received measurement, and wirelessly transmitting the communication signal according to a wireless network protocol.

In another example, a wireless metrology assembly may comprise an input/output controller and a first wireless network controller. The first wireless network controller may be operatively coupled to the input/output controller. The input/output

What is claimed is:

1. A method of communicating a gauge measurement comprising: receiving from a gauge a measurement signal representative of a measurement output by the gauge by a wireless metrology assembly when the wireless metrology assembly is operatively coupled to the gauge; producing from the received measurement signal, by the wireless metrology assembly, a communication signal representative of the measurement; and wirelessly transmitting, by the wireless metrology assembly, the communication signal according to a wireless network protocol.

2. The method of claim 1, wherein wirelessly transmitting the communication signal includes wirelessly transmitting the communication signal according to a ZigBee network protocol.

3. The method of claim 1, further comprising storing a gauge-specific information on a storage device, and wherein producing the communication signal includes producing the communication signal with the gauge-specific information.

4. The method of claim 1, wherein the gauge outputs the measurement formatted according to a first format of a plurality of formats, and producing the communication signal includes producing the communication signal with the measurement formatted according to a second format of the plurality of formats.

5. The method of claim 1, further comprising receiving a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement output by the gauge, and wirelessly transmitting a feedback signal representative of the user input.

6. The method of claim 1, further comprising wirelessly receiving the transmitted communication signal, determining the measurement from the received communication signal, and storing the determined measurement on a first storage device.

7. The method of claim 6, wherein the wireless metrology assembly has firmware and a second storage device, the method further comprising storing on the second storage device a first configuration for the firmware of the wireless metrology assembly, reading on the first storage device a second configuration for the firmware of the wireless metrology assembly, transmitting

the second configuration for the firmware of the wireless metrology assembly wirelessly to the wireless metrology assembly, receiving by the wireless metrology assembly the second configuration for the firmware of the wireless metrology assembly, and replacing on the second storage device the first configuration for the firmware of the wireless metrology assembly with the received second configuration for the firmware of the wireless metrology assembly.

8. The method of claim 6, wherein the gauge outputs the measurement formatted according to a first format of a plurality of formats, and the wireless metrology assembly has firmware; the method further comprising storing a version of the firmware of the wireless metrology assembly for each of the plurality of formats on the first storage device, receiving an indication from a user that the first format is appropriate for the gauge, determining the version of firmware that provides processing of measurements formatted according to the first format, reading the determined version of the firmware from the first storage device, and transmitting the read version of the firmware wirelessly to the wireless metrology assembly, receiving by the wireless metrology assembly the transmitted version of the firmware, and installing the received version of the firmware on the wireless metrology assembly.

9. A method of communicating a gauge measurement comprising: receiving from a gauge a measurement signal representative of a measurement output by the gauge; producing a communication signal representative of the measurement; wirelessly transmitting the communication signal according to a wireless network protocol; wirelessly receiving the transmitted communication signal; determining the measurement from the received communication signal; storing the determined measurement on a first storage device; outputting by a computer to a display device a display signal representative of the measurement output by the gauge; receiving, on a wireless feedback device physically and operatively separate from and independently movable relative to the gauge and relative to the computer, a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement displayed on the display device; wirelessly transmitting by the wireless feedback device a feedback signal representative of the user input; receiving the transmitted feedback signal; and processing the determined measurement based at least in part on the received feedback signal.

10. The method of claim 1, wherein the wireless metrology assembly includes an input/output controller and a wireless network controller operatively coupled to the input/output controller, the

input/output controller receives the measurement signal and produces the communication signal, and the wireless network controller wirelessly transmits the communication signal.

11. A wireless metrology assembly comprising an input/output controller and a first wireless network controller operatively coupled to the input/output controller, the input/output controller configured to receive from a gauge when the wireless metrology assembly is operatively coupled to the gauge, a measurement signal representative of a measurement output by the gauge, and to produce a communication signal representative of the measurement, and the first wireless network controller being configured to wirelessly transmit the communication signal according to a wireless network protocol.

12. The wireless metrology assembly of claim 11, wherein the wireless network protocol is a ZigBee network protocol.

13. The wireless metrology assembly of claim 11, further comprising a metrology storage device configured to store one or more gauge-specific data, and the input/output controller is configured to produce the communication signal with at least one of the one or more gauge-specific data.

14. The wireless metrology assembly of claim 11, wherein the gauge outputs the measurement formatted according to a first format of a plurality of formats, the input/output controller being configured to produce the communication signal with the measurement formatted according to a second format of the plurality of formats.

15. The wireless metrology assembly of claim 11, wherein the wireless metrology assembly is configured to receive a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement output by the gauge, and to wirelessly transmit a feedback signal representative of the user input.

16. A wireless metrology system comprising: the wireless metrology assembly of claim 11; a storage device; a wireless base adapter configured to wirelessly receive the transmitted communication signal; and a computer configured to receive the communication signal from the wireless base adapter, determine the measurement from the communication signal, and to store the determined measurement on the storage device.

17. The wireless metrology system of claim 16, wherein the wireless metrology assembly includes firmware that is configurable, the storage device also stores a first configuration for the firmware of the wireless metrology assembly, the computer is configured to read the first configuration for the firmware of the wireless metrology assembly and to send the first configuration for the firmware of the wireless metrology assembly wirelessly to the wireless metrology assembly via the wireless base adapter, and the wireless metrology assembly is configured to replace an existing second firmware configuration with the received first configuration for the firmware.

18. The wireless metrology system of claim 16, wherein the gauge outputs the measurement signal with the measurement formatted according to a first format of a plurality of formats, and wherein the wireless metrology assembly includes firmware, the storage device also stores a version of the firmware of the wireless metrology assembly for each of the plurality of formats, the computer is configured to receive an indication from a user that the first format is appropriate for the gauge, to read the version of the firmware of the wireless metrology assembly for the first format, and to transmit the read version of the firmware wirelessly to the wireless metrology assembly via the wireless base adapter, and the wireless metrology assembly is configured to install the transmitted firmware of the wireless metrology assembly.

19. The wireless metrology system of claim 16, further comprising a display device operatively coupled to the computer and configured to display a display signal received from the computer, the computer being configured to output to the display device the display signal representative of a measurement output by the gauge, and wherein the wireless metrology assembly includes a gauge adapter including a first housing supporting the input/output controller and the first wireless network controller, the wireless metrology assembly further including a wireless feedback device including a second housing physically separate from and independently movable relative to the first housing, a user-input device supported by the second housing, and a second wireless network controller also supported by the second housing, the user-input device being configured to receive a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement displayed on the display device, and the second wireless network controller being configured to wirelessly transmit a feedback signal representative of the user input to the computer via the wireless base adapter.

20. A wireless metrology system comprising: a wireless metrology assembly having at least one input device configured to receive an indication relating to a measurement, the indication being manually entered on the at least one input device and corresponding to at least one of a plurality of inputs selectable by a user, the wireless metrology assembly being configured to receive from a gauge when the wireless metrology assembly is operatively coupled to the gauge a measurement signal representative of a measurement output by the gauge, to wirelessly transmit a communication signal representative of the measurement signal, and to wirelessly transmit a feedback signal representative of the entered indication; a display device configured to display a display signal; and a base assembly configured to wirelessly receive the transmitted communication signal, to communicate to the display device the display signal including an indication of the measurement output by the gauge, and to wirelessly receive the feedback signal.

21. The wireless metrology system of claim 20, wherein the wireless metrology assembly includes a gauge adapter and a wireless feedback device physically separate from and independently movable relative to the gauge adapter, the gauge adapter being configured to receive from the gauge when the gauge adapter is operatively coupled to the gauge the measurement signal, and to wirelessly transmit the communication signal, the wireless feedback device including the input device and being configured to receive a user input corresponding to one of a plurality of inputs selectable by the user that relate to the measurement displayed on the display device, and to wirelessly transmit the feedback signal representative of the user input to the base assembly.